Exemption No. 10228

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98057-3356

In the matter of the petition of Airbus SAS Section 25.841(a)(2)(i) and (ii), and (a)(3), Amendment 25-87 of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2010-0766**

PARTIAL GRANT OF EXEMPTION

By letter reference no. V21M10029080, dated July 27, 2010, Mr. Jean-Claude Nanche, A350 Chief Airworthiness Engineer, Airbus SAS, 1 Rond Point Maurice Bellonte, 31707 Blagnac Cedex, France, petitioned to exempt the Model A350-XWB (-800, -900, and -1000) series airplanes from the requirements of Title 14, Code of Federal Regulations (14 CFR) 25.841(a)(2)(i) and (ii), and (a)(3), as amended by Amendment 25-87, for certain types of uncontained engine failures. If granted, the exemption would relieve these airplanes, during a decompression caused by those types of failures of the engines, from the requirement that airplane cabin-pressure altitude not exceed 25,000 feet for more than 2 minutes or exceed 40,000 feet for any duration.

The petitioner requests relief from the following regulations:

Section 25.841(a)(2) at Amendment 25-87, requires that:

> The airplane must be designed so that occupants will not be exposed to a cabin pressure altitude that exceeds the following after decompression from any failure condition not shown to be extremely improbable:
>
> (i) Twenty-five thousand (25,000) feet for more than 2 minutes; or
>
> (ii) Forty thousand (40,000) feet for any duration.

Section 25.841(a)(3) at Amendment 25-87, requires that:

Fuselage structure, engine and system failures are to be considered in evaluating the cabin decompression.

The petitioner supports its request with the following information:

This section summarizes the relevant information from Airbus's request. Complete petition information is available at the Department of Transportation's Federal Docket Management System, on the Internet at http://www.regulations.gov, in docket no. FAA-2010-0766. In addition, Airbus provided to the FAA proprietary information regarding the Model A350-900 airplane, and which addressed questions from the FAA pertaining to the Airbus petition.

The Airbus Model A350-900 airplane is designed to cruise at a maximum altitude of 43,000 feet pressure altitude. Should an uncontained engine-rotor failure (UERF) event occur, it is possible that the cabin pressure could exceed the limits contained in current regulations. Airbus offers the following justification in support of its petition for exemption. Some of this justification is based on cabin-decompression evaluations performed and reported by the Mechanical Systems Harmonization Working Group (MSHWG) under the auspices of the Aviation Rulemaking Advisory Committee (ARAC)[1]. In addition, Airbus refers to a recent Aerospace Industries Association (AIA) report titled, *AIA Committee Report on High Bypass Ratio Turbine Engine Uncontained Rotor Events 1969 – 2006 and Small Fragment Threat Characterization*, Volume 1, January 2010, which provides some statistics of basic UERF events in the worldwide fleet between 1969 and 2006. In addition, Airbus has requested that the FAA provide a response on the acceptability of the AIA report. This FAA response to Airbus will be addressed via separate means. Note also that the use of data from the AIA report did not factor significantly into the FAA's decision contained in this partial grant of exemption.

Airbus states that Amendment 25-87 implements restrictions on the maximum allowable cabin altitude that could result from certain failures, including system, structural, and engine failures, unless those failures could be shown to be extremely improbable. It is not possible for the current state-of-the-art methods to ensure that certain engine failures (especially engine-rotor bursts) are extremely improbable. Airbus reports that they have analyzed all UERF scenarios and that most of them result in compliance with the rule. Airbus states that the design of modern aircraft with wing-mounted engines does not permit compliance with the cited requirements for all UERF scenarios; as a practical matter, compliance can only be achieved for such aircraft by restricting flight ceilings. Amendment 25-87 effectively prevents airplanes with wing-mounted engines from operating above 40,000 feet, because an engine-rotor burst potentially could strike the pressurized fuselage at that altitude.

Airbus believes that regulatory adverse effects associated with Amendment 25-87 are accompanied by inconsistent application of the rules, since aircraft presently in the fleet, and those in production whose certification was applied for before the rule became effective, are not required to meet this requirement, even though a simple operational limitation on permissible flight ceiling could be mandated to achieve compliance with the rule. This inconsistent application of this requirement results, Airbus contends, in unfair competitive advantage to such older designs, which have been certificated by the FAA for operation above FL390 (39,000 feet)

[1] The Final Report of the MSHWG, dated August 2003, was approved by a majority of the members of ARAC's Transport Airplane Engine Issues Group (TAEIG). Seven members of TAEIG voted to submit the report as a recommendation to the FAA, two members voted against submitting the report, and one member abstained.

for more than 35 years with no relevant service difficulties having been encountered in the world fleet. Further, the risk to passenger safety that arises from the requested exemption is at a minimum and well within the range of uncertainty of the data available, which purports to show the safety benefit of the rule. Airbus states that granting this exemption does not set a precedent, as the facts and circumstances of this situation are similar to those that led the FAA to grant, e.g., Boeing 787-8 Exemption No. 8857.

Airbus notes that very few, if any, decompression incidents have exposed an airplane cabin to pressure-altitude profiles that pose a risk of injury to passengers. Industry history reveals that few cases of catastrophic decompressions at high altitude have occurred, and those that have occurred have typically involved small business jets. Airbus observes that the FAA has cited few cases of rotor burst in cruise. In one such instance, the crew of a DC-10 crossing New Mexico reported several cases of initial decompression sickness, apparently with no permanent injuries.

Airbus supplied data for the Model A350-900 airplane, using estimated values of airplane rate of descent for several failure scenarios, as required in published FAA policy ANM-03-112-16, titled, *Interim Policy on High Altitude Cabin Decompression* (Reference Amendment 25-87), dated March 24, 2006. In addition, Airbus provided information on the likelihood of various failure events. In its decompression analysis, Airbus included a measure of the severity of exposure for occupants, based on a Depressurization Exposure Integral (DEI) from the MSHWG report, along with data from the AIA report cited above. Airbus used the relationship between cabin pressure and the Depressurization Severity Indicator (DSI), which is a measure of the partial pressure of oxygen, as was proposed by the MSHWG. Airbus showed that, for the worst-case failure modes reviewed for this exemption, the resultant DSI levels were much less than the critical value specified by the MSHWG. Airbus's analysis considers certain design and operational features of the Model A350-900 airplane that would mitigate the effects of an increase in cabin pressure altitude. One of these design features is the cabin pressurization control system (CPCS), which was designed to minimize system failures that would lead to loss of cabin pressurization events.

In addition, Airbus provides information on new design features they incorporated into the Model A350-900 airplane design that Airbus contends will further reduce the risk for occupants to be exposed to low cabin-pressure conditions resulting from system failures:

- A multi-redundant fresh-air supply that will render a cabin depressurization caused by total loss of fresh air nearly extremely improbable.
- Cabin Pressure Control System (CPCS) designs that will have a sophisticated control/monitoring architecture. Furthermore, the dissimilarity principle has been carefully incorporated to prevent any occurrence of common mode failures.

In addition, the Model A350-900 airplane incorporates design features to minimize cabin-decompression hazards for occupants:

- A pair of spoilers that will have an electrical back-up actuation. In case of total loss of all hydraulic power in combination with significant damage to the pressurized fuselage, the aircraft will still be able to deploy a pair of spoilers to descend quickly to a safe altitude.
- A worldwide standard today has, onboard all civil-transport aircraft, first-aid oxygen for occupant hypoxia treatment, as per CS/FAR 25.1443(d) and CS/FAR 121.333(e)(3).

- First-aid oxygen needs to be carried in the cabin for at least two percent of the occupants, and must provide an average flow of 3 liters of oxygen per minute for the entire flight after cabin depressurization occurred. The purpose of first-aid oxygen is to treat those occupants who have suffered from hypoxia by providing the maximum possible blood-oxygen saturation level to ensure the best possible recovery.
- FAR 25.1447(c)(3)(ii) requires the flightcrew be given pressure-demand-type oxygen-dispensing equipment if decompressions that are not extremely improbable may expose the flightcrew to cabin pressure altitudes in excess of 34,000 feet. Compliance with the rule ensures the flightcrew will retain the ability to safely operate the airplane following a decompression.
- As per CS/FAR 25.1443(c), passengers and flight attendants need to be supplied with supplemental oxygen. Those means have been developed and introduced to sufficiently protect cabin occupants against the physiological harm of hypoxia. Various tests reveal that the supplemental-oxygen system provides an adequate protection against hypoxia when the masks are correctly used as shown during the safety briefing before each flight.
- Section 25.1441(d) requires that the oxygen-flow rate and the oxygen equipment used in airplanes operating at high altitudes must be approved. The combination of emergency-descent rate documented in the petition, along with the FAA-approved oxygen masks and associated oxygen-flow rates with which the Model A350-900 airplane is equipped, are adequate to protect the passengers from adverse consequences of a worst-case cabin decompression.

The petitioner's Statement of Public Interest:

The following is quoted from the Airbus petition.

> The Model A350-900 airplane fully complies with FAR 25.841, amendment 87, except with regard to the narrow exemption requested herein. This new aircraft offers a significantly higher level of safety than previously certified transport category aircraft under FAR 25. The exemption requested herein will not adversely affect safety to the occupants. Authorization for flight at FL430 will enable the Model A350-900 airplane to compete fairly with other existing aircraft that are subject to older amendments without causing any adverse effects on passengers.
>
> Approval for flight to 43,000 feet will:
>
> - Enable this new aircraft to fly at FL430, creating more additional lines of aircraft separation in US airspace without adversely affecting the safety of the passengers.
> - Enable the Airbus Model A350-900 airplane to compete fairly with other existing aircraft that are not subject to this amendment without causing any adverse effects to the passengers.
> - Serve the public interest via the use of the new generation engines in the market, as they offer lower operational cost and higher fuel efficiency.
>
> Airplane manufacturers and suppliers will benefit from a granted exemption:

- They will benefit from a competitive aircraft able to find its market. More efficient airplanes that will give continuity to their business.
- Their employees will benefit by sustained employment in the airplane manufacturing industry.
- The public will benefit due to the availability in the future of newer, more efficient airplanes with the possibility of less expensive fares (higher altitudes means less fuel consumption).
- Newer airplanes should also be more reliable reducing the inconvenience of delays and flight cancellations to the public.
- Finally, there is a benefit to the public in that newer, more efficient airplanes flying at higher altitudes will burn less fuel with corresponding less emissions of harmful gases and particulates, and the airspace will be more effectively utilized.

Airplanes not certificated under the FAR would be able to achieve lower operating costs because they could be designed to higher maximum certified altitude. This may give a competitive advantage to non-FAA certificated airplanes, thus promoting a non-level playing field.

Federal Register publication

A summary of the petition was published in the *Federal Register* on December 28, 2010 [75 FR 248]. Two comments, dated January 14 and 18, 2011, were received from the Association of Flight Attendants (AFA); another comment, dated January 19, 2011, was received from the Air Line Pilots' Association (ALPA). These comments are posted in the Federal Docket (regulations.gov) in Docket No. FAA-2010-0766. Both parties initially requested an extended public-comment deadline date. The FAA denied these requests because the FAA has received few to no public comments on prior petitions requesting similar relief; and this is a standard exemption that the FAA has regularly granted in the past to the Airbus A380, Embraer ERJ-170 and ERJ-190, and the Boeing 747-8 and 787.

The AFA and ALPA both provided comments opposing a grant of exemption. Their comments address the following topics:

Topic: The need for additional physiological research on decompression

Both parties recommend that the FAA wait until completion of additional physiological research before addressing the Airbus request for an exemption. The FAA agrees with the need for additional high-altitude-decompression research to validate the analytical methods advocated in both the interim policy and MSHWG report. Our Civil Aerospace Medical Institute (CAMI) is conducting experimental high-altitude-chamber research to validate a human physiological-response model. This research is being conducted to provide additional information on the physiological risk to occupants from a rapid decompression. We view this research as very important and have assigned an engineer to coordinate with our doctors at CAMI. Our strategy is to utilize the results to improve occupant risk assessment. We believe the results of this research, which may not be available until next year, may result in improvements in our Policy on this subject. Should the results show a significant risk above that which we have accepted on other programs, we will take appropriate action and issue new policy. However, at this time, the FAA believes that the limitations we have placed on the design and operation of the A350 support our conclusion.

Topic: FAA Assessment is Flawed

One commenter asserted that:

> It is erroneous to suggest that since the "overall" safety of an aircraft has been improved, it is acceptable for one specific area to be exempted. Certification is not a matter of increasing safety in one area so that a higher risk (lower level of safety) is acceptable in another area.

The FAA believes that it is entirely appropriate to consider the concept of "overall" airplane safety in this matter. The FAA considers risk as well as benefits to the public within any petition for exemption. If improvements are made in areas affected by failures that have a higher probability of occurring, these should weigh into consideration versus events which are acknowledged by all parties as "rare," as in the case of a rapid decompression at high altitude.

One commenter asserted that:

> The FAA should reassess its assumptions in light of the recent Qantas flight 32 engine failure. In the AIA report cited above, high bypass ratio turbine engine uncontained rotor events that occurred between 1969 and 2006 were considered. According to the report and subsequently highlighted in the Airbus petition, "There have been no events from 3rd generation engines," which includes the GE90, CFM56-7, CF34-10, PW4000 100" and 112" fan, PW6000, Trent and BR715.

The FAA has already completed an assessment of the noted AIA report and disagreed with the conclusions noted within. In addition, it should be noted that EASA and FAA specialists were in agreement. Therefore, the AIA report did not factor into the FAA evaluation of the Airbus A350 petition for exemption.

One commenter asserted that:

> A small section of liberated turbine disc penetrated the left wing-to-fuselage fairing, resulting in damage to numerous system components, the fuselage structure and elements of the aircraft's electrical wiring. This is significant in light of the email correspondence between Airbus and FAA reproduced in a document obtained through the petition docket FAA-2010-0766; where it is stated that "[i]n analyzing system and structural damage caused by fragments from an UEF, additional structural damage can be assumed to be limited to that engine. Regarding engine powered systems, other than loosing [sic] the thrust, engine bleed air, and engine accessory power on the engine suffering the UEF, the operation of other airplane systems can be assumed to be normal. Therefore, the airplane should be capable of performing a V_{mo}/M_{mo} emergency decent (i .e ., spoilers fully deployed if appropriate, maximum descent rate, V_{mo}/M_{mo} speed)."

The FAA's position to restrict the decompression scenario, used in the assessment, to one where the uncontained engine failure results in the largest hole to the pressurized vessel, as noted in the FAA Policy Memorandum ANM-03-112-16, remains valid at this time. While the Airbus incident did demonstrate an uncontained engine failure resulting in the loss of several systems, it did not result in a decompression event. We have used information from debris models in our policy and evaluation of decompression events. In addition, the current FAA policy is in agreement with the recommendation of the MSHWG report on § 25.841(a). The FAA's position may be altered during subsequent rulemaking on this subject to ensure that appropriate decompression scenario(s) is/(are) evaluated (i.e., which agree with established guidance in associated FAA regulations and advisory material such as § 25.1309). However, at this time, the FAA believes our position affords an appropriate level of safety considering the likelihood of the worst-case decompression scenario.

Topic: FAA-Required Validation Flight Tests

One commenter asserted that:

> ...validation flights [should] be conducted by [Airbus] to determine actual descent rates achievable in potential rapid depressurization situations. It is necessary to determine exact descent rates achievable by the aircraft in operationally realistic descent profiles and correlate those times with safe exposure times to passengers and crew.

The FAA agrees with the commenter. We have required flight-test confirmation of airplane-descent speeds on previous grants of exemption. We will require that Airbus perform validation flights to demonstrate descent rates. Airbus will conduct the necessary flight tests to demonstrate that the airplane is capable of achieving the descent speeds needed to meet the FAA pass/fail criteria. The FAA will review the reports upon their completion. However, certification to 14 CFR part 25 requirements serves as a demonstration that an airplane meets minimum "design" requirements. We acknowledge no guarantee that a pilot will fly the descent to V_{mo}/M_{mo} speed following a rapid decompression.

The FAA's Analysis

1. Need for exemption

Airbus requests relief from § 25.841(a)(2)(i), which specifies that cabin pressure altitude may not exceed 25,000 feet for more than 2 minutes after decompression from any failure condition not shown to be extremely improbable. A grant of exemption from this regulation would allow the Model A350-900 airplane to take longer than 2 minutes to descend from 43,000 feet to 25,000 feet after such decompression.

In addition, note that Airbus requested an exemption for the Model A350 "XWB" series airplanes, which includes -800, -900, and -1000 model variants. The FAA has determined that only the Airbus Model A350-900 airplane is eligible for this exemption at this time, due to the lack of the maturity of the information on the -800 and -1000 model variants and due to airplane performance issues (e.g., airplane descent speed).

Airbus also requests relief from § 25.841(a)(2)(ii) which specifies that cabin pressure altitude may not exceed 40,000 feet for any duration after decompression from any failure condition not shown to be extremely improbable. A grant of exemption from this regulation would allow the Model A350-900 airplane cabin pressure altitude to exceed 40,000 feet after such decompression.

Based upon data received from Airbus, the FAA's analysis confirms that the design of the Model A350-900 airplane meets the requirements of § 25.841(a)(2)(i) and (ii) for all system and structural failures not shown to be extremely improbable but not for all types of engine failures. For some UERF that result in pressure-vessel penetration by fragments, the design of the Model A350-900 airplane does not meet the requirements of § 25.841(a)(2)(i) and (ii). A grant of exemption from this regulation would allow the Model A350-900 airplane to operate up to 43,000 feet, which could briefly expose cabin occupants to this altitude in the event of a worst-case decompression.

Finally, Airbus requests relief from § 25.841(a)(3), which requires that an airplane manufacturer consider fuselage structure, engine, and system failures when evaluating the cabin pressure altitude following a decompression due to one of these failure events. As noted in the preamble to this regulation:

> Possible modes of failure to be evaluated include malfunctions and damage from external sources such as tire burst, wheel failure, uncontained engine failure, engine fan, compressor or turbine multi-blade failure, and loss of antennas…

The FAA's analysis shows that Airbus did include consideration of these failures in its analysis. Therefore, Airbus complies with § 25.841(a)(3), eliminating the need for an exemption from it.

2. Conformance with applicable FAA policy

The FAA reviewed this petition in the context of the MSHWG Final Report on § 25.841(a)(2) and (a)(3) and of our Interim Policy on Amendment 25-87 Requirements. The Interim Policy applies only to those decompression events which are due to UERF. The basis of the Interim Policy is data from research on the response of humans and other primates to changes in ambient pressure. Evaluation of this data indicates a direct correlation between the alveolar partial pressure of oxygen time integral and the likelihood of fatalities or permanent physiological damage to those exposed to such pressure changes. That is, as the value of the integral increases, the likelihood of fatalities or permanent physiological damage also increases. However, to simplify the FAA accepted "pass/fail criteria," the FAA has issued a final version of our Interim Policy, which uses a table of altitudes and cumulative exposure times in lieu of the pressure-time integral. Note that the values of altitude and time in the table, and the results of the pressure-time integral method, are in agreement.

Accordingly, our Interim Policy focuses on minimizing the likelihood that, if a person is exposed to high-altitude cabin pressure from any failure not shown to be extremely improbable, he will suffer permanent physiological damage. To analyze petitions for exemption from § 25.841(a)(2), the FAA requires information about emergency-descent rates, any design features that increase such rates, other design features that offset the inherent increased risk of exposure to high-altitude cabin pressure, and operational procedures.

As stated above and in our Interim Policy, the FAA acknowledges a lack of relevant data on the effects of exposure to high-altitude cabin pressure following decompression and, particularly, those effects on people of various ages, and on people with circulatory or respiratory diseases or certain other medical conditions.

The FAA supports a research program to gather additional information on the effects of exposure to high-altitude cabin pressure. The FAA Office of Aerospace Medicine's Civil Aerospace Medical Institute (CAMI) has developed a physiological model to determine the impact of hypoxia on occupants. The FAA is currently preparing to conduct altitude-chamber studies to support validation of their physiological model. This research is an integral part with our rulemaking to develop a new standard for cabin pressure altitude following decompression.

Our review of the Airbus petition indicates that Airbus used the methodology recommended in the FAA's Interim Policy. The FAA believes that this methodology is conservative in the sense that it assumes a lower partial pressure of oxygen than would likely be present during decompression at 43,000 feet.

Airbus provided descent profiles for the Model A350-900 airplane, based on conservative estimates of descent performance for several failure scenarios, as described in the FAA's Interim Policy. The descent profiles indicate that the Model A350-900 airplane can descend rapidly from 43,000 feet altitude to below 25,000 feet and meet the pass/fail criteria within our policy.

Airbus also performed a depressurization analysis, based upon maximum-cruise flight conditions, and defined the envelope of vulnerability of passengers following failures that result in a decompression, and identified design and operational features of the Model A350-900 airplane which would mitigate the effects of an increase in cabin pressure altitude.

The decompression analysis used several measures recommended in the Final Report of the ARAC MSHWG. Specifically, Airbus estimated the severity of exposure to high-altitude cabin pressure for occupants, based on calculation of a DEI. The analysis also considers the relationship between cabin pressure and the DSI, a measure of the partial pressure of oxygen. The analysis indicates that the physiological effect of a slight increase in the length of time spent above 25,000 feet is within the uncertainty band of available physiological data. The Airbus analysis also shows that, for all of the failures modes reviewed for this exemption, resultant DSI levels were much less than the critical value recommended by the MSHWG.

The FAA reviewed information provided by Airbus about design features and operational procedures that would increase the descent capability of the Model A350-900 airplane and/or occupant survival. We concluded that the design features and operational procedures associated with rapid decompression, followed by an emergency descent, support this partial grant of exemption.

3. Review of historical data and research

The FAA reviewed databases from its own National Aviation Safety Data Analysis Center (now called the Aviation Safety Information Analysis and Sharing (ASIAS) database), containing data gathered between the years 1959 to 2006. Within that time, data surveyed show approximately 3,000 instances of cabin-pressure loss. The vast majority of these have been caused by system failures (e.g., cabin-pressurization-controller failures, valve failures, etc.) and structural failures (e.g., door-seal failures), which typically have been recognized at low altitude within a few minutes after takeoff. Pilot error also has contributed to the number of events. The majority of these events have not subjected the occupants to exposures above 25,000 feet (an altitude considered physiologically significant). The cabin pressure altitude in most events did not exceed 15,000 feet (the cabin pressure altitude at which passenger oxygen masks are deployed).

Similarly, UERF tend to be very rare. A simple calculation shows that grouping all engines and transport airplanes together yields an average probability of an UERF at cruise of approximately 1×10^{-7} per engine hour. New engine designs appear to reduce this probability by an order of magnitude. We found, as noted in the MSHWG report on § 25.841(a), that no fatalities from hypoxia were due to in-flight rapid decompression events as envisioned by Amendment 25-87. The data indicate that decompression is not a significant cause of fatalities. It is because these events are so rare that the FAA considers the risk of flight above 40,000 feet pressure altitude to be acceptable.

In addition, Airbus provided the FAA with proprietary data from its analysis of UERFs, and the size and number of holes in the fuselage resulting from such failures. Using historical data, Airbus performed decompression analysis for several scenarios. Airbus analyzed the probability of UERF and of penetration of the fuselage of the Model A350-900 airplane from fragments of various sizes resulting from such failures. The FAA used this analysis to assess the threat to occupants in such an airplane event.

The FAA concurs with Airbus that UERFs are rare events, and this consideration had a bearing on the granting of the exemption. Our analysis in this case is in contrast to our analysis of an earlier petition for exemption from a different applicant for an airplane with a lower cruise altitude. The petition submitted by the previous applicant included estimates of the probability of occurrence of an UERF. In that case, the altitude excursion above 40,000 feet was less than 1,000 feet. We concluded that the risk associated with exposure of the occupants to the slightly higher altitude was essentially the same as the risk of exposure at 40,000 feet. In other words, the risk from exposure at altitude was essentially the same with or without the grant of the exemption. Therefore, the rarity of UERFs did not significantly enter into consideration regarding the previous grant of exemption.

4. Holes from UERF

The FAA evaluated the Airbus approach for determining the size of holes in the fuselage and/or wings caused by UERF. While we concluded that the method makes some assumptions which one could question, the presence of the assumptions is not of great significance since the FAA required Airbus to assume a failure which produced a very large hole in the fuselage, causing a sudden decompression. Airbus evaluated this scenario and provided the results in its petition.

5. Use of supplemental oxygen

As discussed in further detail below, the FAA has analyzed the Airbus petition in the context of those recommendations, the part 25 requirements pertaining to supplemental oxygen, and certain technical standards for supplemental-oxygen equipment.

Section 25.1441(d) requires approval of oxygen equipment for airplanes that are approved to operate above 40,000 feet altitude. Section 25.1443 specifies the minimum mass flow of supplemental oxygen for flightcrew and passenger oxygen systems up to a cabin altitude of 40,000 feet. Part 25 does not contain standards for oxygen systems above 40,000 feet. However, FAA Technical Standard Orders (TSOs) provide requirements for diluter demand pressure-breathing regulators (TSO-89) and demand oxygen masks (TSO-78) up to 45,000 feet. In addition, the Society of Automotive Engineers (SAE) Standard AS 8027 provides specifications for diluter demand pressure-breathing regulators up to 45,000 feet. It is the FAA's understanding that no diluter demand pressure-breathing regulators available for commercial airplanes meet all the requirements of TSO-89 or AS 8027.

As part of the validation work on the Model A350-900 airplane, the FAA requested that Airbus propose performance standards for fixed and portable oxygen systems for the flightcrew, flight attendants, and passengers to use between 40,000 and 43,000 feet cabin altitude. We also requested that Airbus substantiate the adequacy of the proposed performance standards. Airbus provided test results and analysis which substantiate that the proposed standards for oxygen pressure-breathing equipment would adequately protect the flightcrew in the event of decompression to 43,000 feet.

Flightcrew pressure-breathing equipment requires training to ensure effective use. Pressure breathing requires physical effort to exhale and minimal effort to inhale. This reversal of the normal breathing cycle can lead to hyperventilation. Training of passengers to use pressure-breathing equipment safely is considered impractical. The FAA determined that an acceptable means of compliance for the fixed- and portable-oxygen systems used by flight attendants and passengers would be to install oxygen equipment that is certificated to 40,000 feet, and limit exposure to the reduced pressure environment above 40,000 feet via airplane-descent performance. The FAA believes that, ultimately, occupant survival during a decompression event depends upon swift descent to a lower altitude. In its review of Airbus's airplane-descent profile, the FAA finds that the Model A350-900 airplane can descend at acceptable rates to alleviate occupant exposure hypoxia.

6. Conclusion of FAA analysis

Permitting airplanes to fly above 40,000 feet does offer real and tangible benefits to the aerospace industry, the traveling public, and the U.S. economy by reducing congestion, improving fuel economy, and reducing pollution. If compliance with § 25.841 at Amendment 25-87 were to limit airplane operations to a maximum altitude of 40,000 feet, it would impose a significant disadvantage on newly designed airplanes that have many safety advantages over older airplanes currently allowed to operate at higher altitudes. This would delay the introduction of these airplanes and the benefits of their more advanced technology.

Based upon its evaluation of the data and analysis provided by Airbus, the FAA has determined that Airbus has sufficient justification for a partial grant of exemption from § 25.841(a)(2)(i) and (ii). Regarding the provisions of § 25.841(a)(3), Airbus included in its analysis consideration of engine failures. In addition, as part of the normal certification process, Airbus will consider fuselage structure and system failures. Therefore, relief from this requirement is not necessary.

The partial grant of exemption from § 25.841(a)(2)(ii) will permit cabin pressure altitude to exceed 40,000 feet for 1 minute (but not to exceed 43,000 feet for any duration) after decompression from any UERF condition not shown to be extremely improbable. The partial grant of exemption from § 25.841(a)(2)(i) will permit cabin pressure altitude to exceed 25,000 feet for more than 2 minutes (but not more than 3 minutes) after decompression from any UERF condition not shown to be extremely improbable, allowing time for the airplane to descend from an altitude of 43,000 feet to 25,000 feet.

This partial grant of exemption does not provide relief from § 25.841(a) for any other system and structural failure events not shown to be extremely improbable. Airbus must demonstrate compliance for those failures events, and this partial grant is predicated on the belief that the applicant will successfully demonstrate that compliance for the Airbus Model 350-900 airplane. As noted in the MSHWG report on § 25.841(a), tire burst in-flight is not extremely improbable as demonstrated by historic data. Therefore, the tire-burst event must be considered in the depressurization analysis. In addition, pressure-vessel openings resulting from loss of antennas, or stall warning vanes, or any system failure conditions that are not shown to be extremely improbable must be considered. The effects of such damage while operating under maximum normal cabin pressure differential must be evaluated. Also, structural cracks will be addressed as per the existing Amendment 25-87 preamble, i.e.:

> The maximum pressure vessel opening resulting from an initially detectable crack propagating for a period encompassing four normal inspection intervals. Mid panel cracks and cracks through skin stringer and skin frame combinations must be evaluated.

In addition, this partial grant of exemption is predicated on the requirement that the Airbus Model 350-900 successfully demonstrates compliance to §§ 25.1441, 25.1443, 25.1445, 25.1447, and 25.1449.

This partial grant of exemption takes into account operating rules in 14 CFR parts 91, 121, and 135 which require that;

- one pilot wear and use his oxygen mask when operating above 41,000 feet altitude and
- an adequate quantity of oxygen is provided for crew operations.

This partial grant of exemption is also premised on the condition that:

- In the Airplane Maintenance Manual, the airplane manufacturer and the airline operator include any required maintenance and checks of supplemental-oxygen systems prior to each flight.
- If dispatch is deemed appropriate with a malfunctioning system that is required to ensure that the airplane is capable of performing an emergency descent (i.e., spoilers fully deployed, if appropriate; maximum descent rate; maximum operating limit V_{MO}/M_{MO} speed), the Master Minimum Equipment List (MMEL) must limit dispatch to a maximum flight altitude of 40,000 feet, unless other regulations or limitations require a lower altitude. Though V_{MO}/M_{MO} is normally the best speed for a rapid decompression descent, the pilots should follow the recommended emergency-descent procedures in the Airplane Flight Manual (AFM). Rather than place an MMEL dispatch limitation as an explicit condition of granting this partial exemption, we have determined that it is appropriate for the FAA Flight Operations Evaluation Board to evaluate the matter of dispatch with a malfunctioning system that is required to ensure that the airplane is capable of performing an emergency descent (e.g., the pair of spoilers that are provided with electrical back-up actuation).
- The applicable rapid-decompression procedures for the flightcrew must be included in the emergency procedures section of the AFM. This information should also be included in the Airbus Flight Crew Operating Manual.
- Initial and recurrent emergency training for all crewmembers, in accordance with §§ 121.397, 121.417, and 121.427, must include training for a rapid decompression and donning of oxygen masks.

The FAA's decision

In consideration of the foregoing, I find that a partial grant of exemption is in the pubic interest regarding 14 CFR 25.841(a)(2)(i) and 25.841(a)(2)(ii) as amended by Amendment 25-87. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701, delegated to me by the Administrator, the petition of Airbus for an exemption from the requirement of 14 CFR 25.841(a)(2)(i) and 25.841(a)(2)(ii), as amended by Amendment 25-87, is granted.

Regarding the provisions of § 25.841(a)(3), Airbus complies with the regulation, since its analysis did consider fuselage structure, engine failures, and system failures. Therefore, relief from this requirement is not necessary.

Regarding the request that this exemption be applicable to the Airbus Model A350-800, -900, and -1000 series airplanes, the FAA has determined that this was not acceptable due to the concerns addressed in our analysis. Therefore, this partial grant is applicable to the Airbus Model A350-900 airplane only.

The partial grant of exemption from § 25.841(a)(2)(ii) will permit cabin pressure altitude to exceed 40,000 feet for 1 minute, but not to exceed 43,000 feet for any duration, after decompression from any UERF condition not shown to be extremely improbable. This partial grant of exemption from § 25.841(a)(2)(i) will permit cabin-pressure altitude to exceed 25,000 feet for more than 2 minutes, but not more than 3 minutes, after decompression from any UERF condition not shown to be extremely improbable, allowing time for the airplane to descend from an altitude of 43,000 feet to 25,000 feet.

This partial grant of exemption is subject to the following conditions:

1. The Model A350-900 airplane AFM must indicate that the maximum indicated operating pressure altitude is 43,000 feet.
2. The Model A350-900 airplane AFM must contain applicable flightcrew procedures for a rapid decompression event. The section of the AFM that pertains to actions in the event of a decompression must state that the flightcrew should initiate a descent at the maximum rate of descent and safe descent speed, which is typically the maximum operating speed (V_{MO}/M_{MO}), assuming structural integrity of the airplane.
3. Airbus must submit certification flight-test data for the Model A350-900 airplane that corroborate the descent profiles used in the analysis to show that, after decompression at an airplane indicated operating pressure altitude of 43,000 feet, the cabin pressure altitude will not exceed 25,000 feet for more than 3 minutes or 40,000 feet for more than 1 minute.

Issued in Renton, Washington, on MAR 18 2011

KCYanamura

K. C. Yanamura
Acting Manager, Transport Airplane Directorate
Aircraft Certification Service